The Development Of Rice Grains under Controlled Environment III Germinability of Seeds Ripened under Different Environmental Conditions

Tohoku Journal of Agricultural Research
Vol. 24, No. 1, May 1973
Printed in Japan

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III Germinability of Seeds Ripened under Different Environmental Conditions

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(Received, April 18, 1973)

Summary

Using the seeds obtained in the previous experiments (4, 5), the effects of temperature combined with light-intensity and air-humidity during the ripening period on the germinability of the seeds were examined.

In Norin-17, a japonica variety distributed in northern Japan, the best ripening condition for germinability was 20° day-temperature combined with strong light and low air-humidity. Day-temperture of 30° was harmful for seed, although the germinability was considerably improved by lowering night temperatures. In contrast, for IR-8 seeds, an indica variety distributed in the tropical regions, 30° or 35° day-temperature combined with strong light and low air-humidity was the best ripening condition. In the former variety seed weight had a significant correlation with germinability, while in the latter there was no correlation found, suggesting a varietal difference in seed vigorousity responding to temperature during ripening period.

There are places called "Taneba" where rice plants have been grown traditionally only to sell the produced grains as seeds to farmers. The air-temperature of "Taneba" is characterized by having a greater daily range, and the seeds produced there usually have greater 1000-kernel weight, although other factors not identified yet may be involved (3). There is no definite report on the effect of temperature combined with other factors during ripening period upon the subsequent germinability and seedling vigour of the matured seeds.

The author reported in the previous papers (4, 5) the ripening processes of rice grains under different environmental conditions. This paper is presented to show the germinability of the seeds obtained from the above experiments.

Materials and Methods

The seeds ripened at different day-night temperatures under 16-hr photoperiod (4) (8-hr natural daylight plus 8-hr supplemental light), and the seeds obtained at different air-temperatures combined with two light intensities and two air-

TABLE 1. *Germinability of Rice Seeds Matured under Different Temperatures (1967) and under Different Air-humidity, Light Intensity Combined with Different Temperatures (1968), Tested on January, 1968 and March to April, 1969, Respectively.*

Variety	Day-Night[1] temp. °C	GS[2] at 10 days, %	GC[2] at 20 days, %	Day-Night[1] temp. °C	RH[3] L I	At 30°C GS[4]	At 30°C GC[4]	At 15°C GS[4]	At 15°C GC[4]
NORIN-17	35-35	4	4	35-30	H	0	89	3	76
	-30	7	55		L	4	100	9	84
	-25	49	72		S	0	98	14	92
	-20	25	54		W	0	82	3	58
	-15	4	63	30-25	H	17	92	4	76
	30-30	32	60		L	33	92	13	78
	-25	62	99		S	48	98	65	98
	-20	61	94		W	16	91	29	86
	-15	52	90	25-20	H	95	100	47	99
	-10	0	52		L	84	100	68	98
	25-25	27	98		S	69	100	40	98
	-20	34	99		W	18	90	11	75
	-15	60	90	20-15	H	94	100	90	98
	20-20	95	100		L	96	100	95	99
	-15	89	100		S	89	98	86	99
	-10	85	100		W	79	100	91	99
IR-8	35-35	37	48	35-30	H	10	99	10	98
	-30	37	81		L	16	98	6	100
	-25	43	92		S	12	100	5	96
	-20	61	98		W	6	96	5	90
	-15	1	40	30-25	H	34	100	3	99
	30-30	52	97		L	51	99	36	99
	-25	59	91		S	43	100	30	99
	-20	76	96		W	30	100	58	100
	-15	48	96	25-20	H	47	100	42	98
	-10	29	87		L	29	100	41	100
	25-25	43	65		S	45	100	45	100
	-20	10	72		W	35	100	12	95
	-15	34	65	20-15	H	28	100	9	99
	20-20	10	52		L	36	100	1	98
	-15	1	43		S	16	99	1	97
	-10	0	11		W	11	100	0	99

1) Under these temperature regimes the seeds were matured in the fall of the previous year.
2) GS: germination speed, GC: germination capacity. Germinability was tested at 15°C.
3) RH: relative humidity, H: high-humidity, 70–80%, L: low-humidity, 50–60%. LI: light-intensity, S: strong, W: weak.
4) GS at the 1st day at 30° and at the 6th and the 4th day at 15° for Norin-17 and IR-8, respectively. GC at the 10th and the 5th day at 30° and at the 15th and the 10th day at 15°, for Norin-17 and IR-8, respectively.

humidity (both under 12-hr natural light) (5) were tested for germinability. The former seeds were harvested in the fall of 1967 and used for germination test on January 1968, and the latter were harvested in 1968 and tested on March and April for Norin-17 and IR-8, respectively, in the next year.

After one day soaking in water and sterization, each 50 seeds were put on the doubled moist filter papers in Petri' dishes of 8.5 cm in diameter. Every plot consisted of two dishes. The dishes were put into an incubater held dark at 15° in 1968, at 15° and 30° in 1969. Every morning the dishes were taken out of the incubater, the germinated seeds being counted and the water replenished. Germination speed and germination capacity (percentage) were calculated as shown in Table 1. The seed having a coleoptile more than 1 mm length was recognized as a germinated seed.

Results and Discussion

I. *Air-temperature with Differential Daily Ranges*

The effects of differential temperature conditions during ripening period on the subsequent germinability of the seeds are shown in Table 1 and Fig. 1. The seeds ripened at a very high temperature as 35–35° (day-night) gave low germination speed and capacity in both varieties, especially in Norin-17 which showed only 4 per cent germination. However the germinability was improved by lowering the night-temperatures at an appropriate level. In IR-8, 5 to 15° decline of night-temperature increased the germination capacity up to 80 to 98 per cent, while in Norin-17 it is still low with 50 to 70 per cent. Sudden drop of night-temperature as 20° (35–15°) retarded germination very much in both varieties. IR-8 seems to be more resistant to high temperatures than Norin-17.

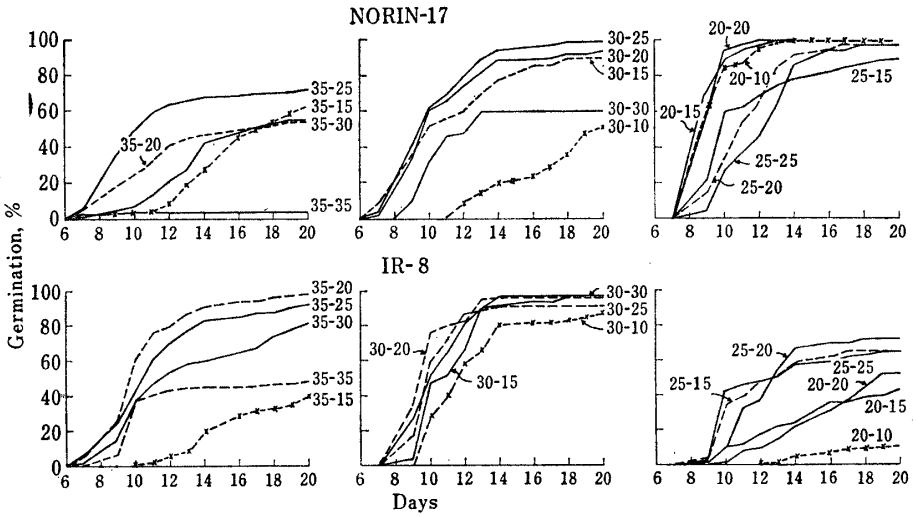

Fig. 1. Germination processes at 15°C of the seeds matured under different day-night temperatures (°C). Seeds were harvested in the fall of 1967 and tested for germinability on January, 1968.

Ripening day-temperature of 30° was generally better for germination than 35° in both varieties, attaining more than 90 per cent germination when the night-temperatures declined 5 to 15°. Sudden drop as 20° (30–10°) was harmfull for the germination of both varieties. IR-8 and Norin-17 showed almost 100 and 60 per cent germination, respectively, when ripened at 30–30°.

At 25° ripening day-temperature, the both varieties did not germinate so well as may be anticipated probably because of an unknown physiological disease which occurred during the ripening period (4). At 20° ripening day-temperature, Norin-17 showed the best germinability of all the plots, while IR-8 showed the worse germination than at 25° giving only 11 per cent.

The best ripening day-temperatures for germination were 20° and 30°, being followed by 25°, 30°, 35° and by 35°, 25°, 20° in order, in Norin-17 and IR-8, respectively. It may be concluded that Norin-17 is adapted to cooler environment and IR-8 to warmer condition as far as the germinability of the produced seeds are concerned.

II. *Air-temperatures Combined with Light-intensity and Air-humidity*

The effects of defferential temperatures combined with light-intensity and air-humidity during ripening period on the germination of the matured seeds are shown in Table 1 and Fig. 2 and 3.

At 30° seed-bed temperature, the speed and capacity of germination of Norin-17 seeds matured at 25° and 20° day-temperatures were very high at the 2nd day, especially so at 20°. On the contrary, 35° and 30° day-temperatures retarded the germinability except at 35–30°L, 35–30°S and 30–25°S where the germination capacity reached almost 100 per cent. Strong light and low air-humidity were favorite for germinability improvement.

At 15° seed-bed temperature, almost the similar tendency was observed, 20–15° being the best for germinability followed by 25–20° together with strong light and

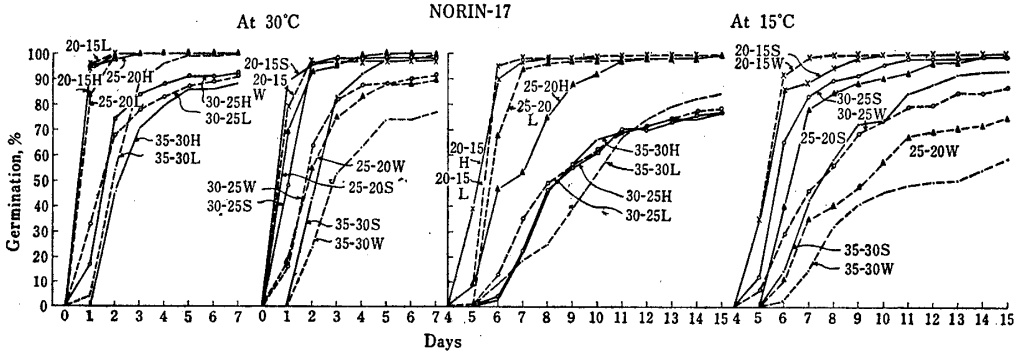

Fig. 2. Germination processes at 30° and 15°C of the seeds matured under different day-night temperatures (°C) combined with air-humidity (H: high humidity, L: Low humidity) and light-intensity (s: strong, w: weak). Seeds were harvested in the fall of 1968 and tested for germinability on March, 1969 (NORIN-17).

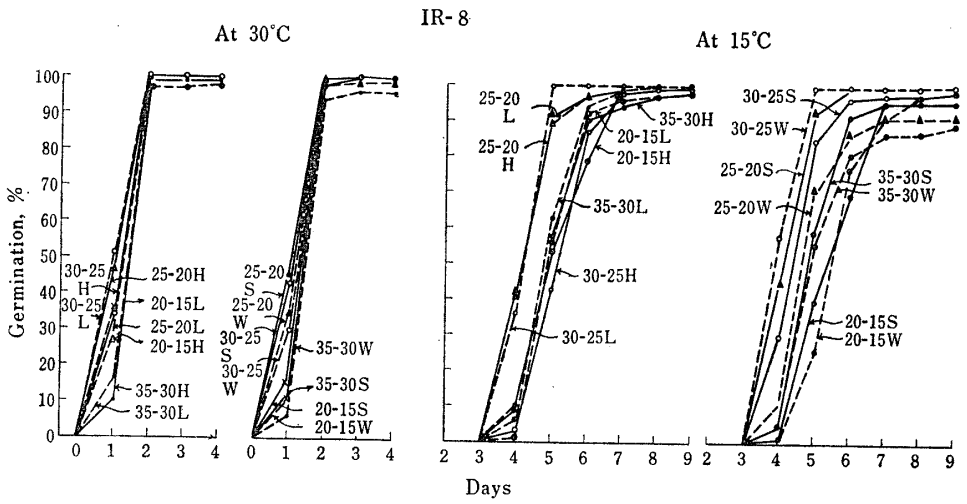

Fig. 3. Germination processes at 30° and 15°C of the seeds matured under different day-night temperatures (°C) combined with air-humidity (H: high humidity, L: low humidity) and light-intensity (s: strong, w: weak). Seeds were harvested in the fall of 1968 and tested for germinability on April, 1969 (IR-8)

low humidity. The seeds matured at 35–30°, 30–25° were slow in germination speed, especially so at the former. Under these high temperatures weak light and high humidity were harmfull for germinability.

The IR-8 seeds which were tested at 30° seed-bed on April, germinated more than 95 per cent at the 2nd day at all the plots, probably because of the promotion of germination processes during one day pre-soaking in water of warmer temperature on April (Fig. 3). At 35–30°, 20–15° plots, however, the germination was retarded one day. In general, strong light and low air-humidity gave a little good effect. At 15° seed- bed temperature, the above differences were more expanded. In IR-8, 25–20° and 30–25° ripening temperatures were better conditions for germinability as contrast to 20–15° in Norin-17.

III. *Seedling Vigor*

The germinated seeds at germination test I and II were transfered to the vermiculite bed without fertilization at 3 cm interval and their seedling growth was estimated as shown in Table 2.

There was no such a significant difference among plots in seedling growth as was found in germinability, although the growth from 20° day-temperature was a little better than the others in both varieties. This may partly be due to the possibility that the seeds of relatively uniform vigorousity have been used, since the seeds germinated almost at the same date were selected.

It may be concluded that for Norin-17 which is distributed in northern Japan, 20° day-temperature is the best condition not only for grain weight as shown in the previous report (4), but also for seed vigorousity, whereas for IR-8 which is

TABLE 2. *The Growth of Seedlings on the Vermiculite Bed in a Greenhouse. The Germinated Seeds at the Germinating Test were Transplanted on the Bed with Abundant Moisture but no Fertilizer (Means of 15 plants in 1968 and 10 plants in 1969)*

Day-Night temp. °C	NORIN-17 (1968)			IR-8 (1968)		
	Height, cm	Leaf no.	DW of shoot, g	Height, cm	Leaf no.	DW of shoot, g
35-35	34	6.8	0.15	18	7.1	0.10
-30	34	6.8	0.18	17	6.9	0.10
-25	32	6.5	0.14	16	6.7	0.07
-20	30	6.6	0.11	14	6.3	0.04
-15	34	6.8	0.19	19	7.4	0.11
Mean	33	6.7	0.15	17	6.9	0.08
30-30	27	6.5	0.08	17	6.9	0.10
-25	30	6.7	0.12	17	7.2	0.10
-20	35	6.8	0.19	17	6.7	0.09
-15	36	6.5	0.19	19	7.1	0.14
-10	32	6.3	0.13	20	7.6	0.17
Mean	32	6.6	0.14	18	7.1	0.12
25-25	33	6.3	0.14	18	7.2	0.10
-20	28	6.2	0.11	20	7.4	0.11
-15	33	6.2	0.16	18	7.5	0.14
Mean	31	6.2	0.14	19	7.4	0.12
20-20	35	6.8	0.20	18	6.7	0.12
-15	34	6.3	0.17	21	7.5	0.18
-10	33	6.3	0.15	21	7.5	0.16
Mean	34	6.5	0.17	20	7.2	0.16

Day-Night temp. °C	RH L I	NORIN-17 (1969)	
		Height, cm	Leaf no.
35-30	H	10.1	3.7
	L	9.5	3.7
	S	9.0	3.7
	W	9.2	3.7
30-25	H	9.6	3.8
	L	10.2	3.5
	S	8.8	3.7
	W	9.5	3.7
25-20	H	10.1	3.5
	L	9.9	3.5
	S	10.3	3.4
	W	9.9	3.5
20-15	H	10.3	3.5
	L	9.6	3.7
	S	11.4	3.6
	W	11.0	3.6

Notes: Materials in 1968 were obtained from the germination test at 15°C and those in 1969 were from the test at 30°C. The former data were taken on March 25, the latter on March 31, 44 and 18 days after the transplanting, respectiely.

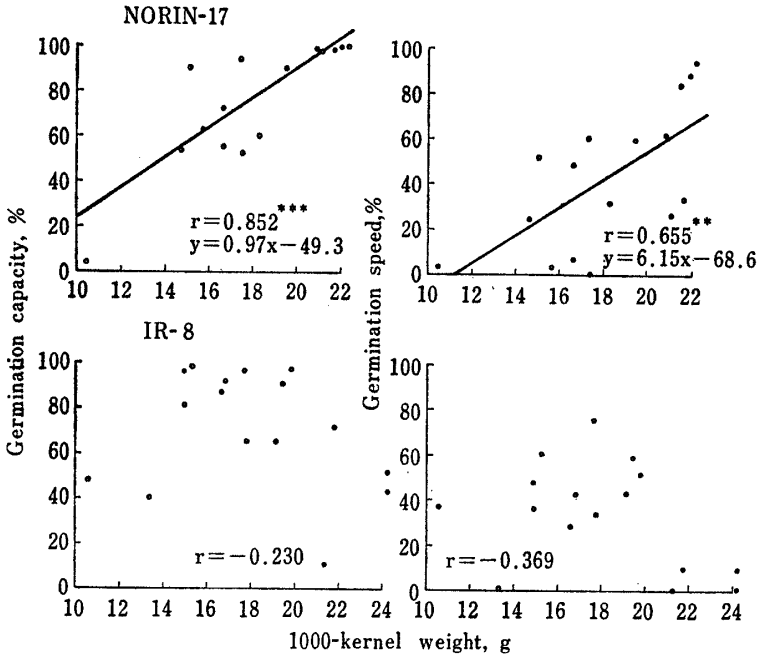

Fig. 4. Correlations between germinability and 1000-kernel weight of the seeds ripened under differential temperatures (1968).

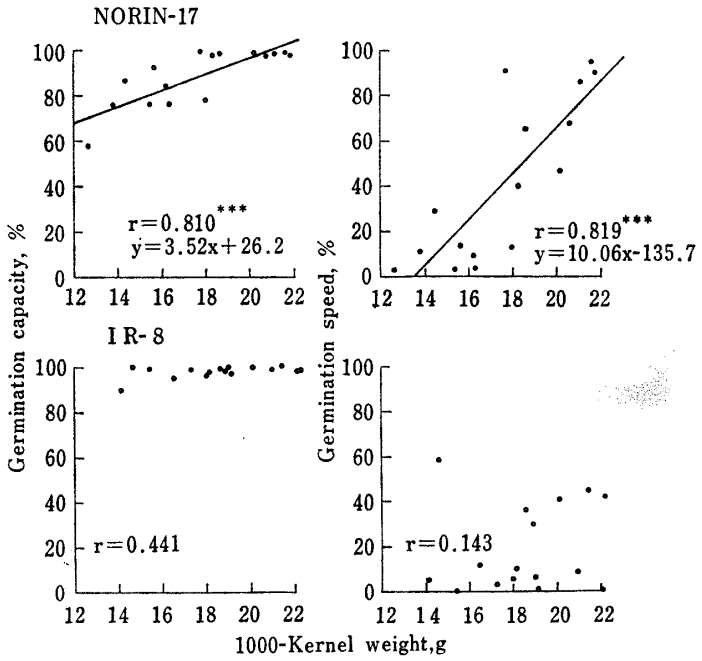

Fig. 5. Correlations between germinability and 1000-kernel weight of the seeds ripened under different temperatures combined with light-intensity and air-humidity (1969)

grown in the tropical regions 30° day-temperature is the best for seed vigorousity followed by 35° with lowered night-temperatures at an appropriate level.

In Norin-17, the germinability was significantly correlated with 1000-kernel weight, but in IR-8 there was no correlation between the two (Fig. 4, 5). For

the grain development, both Norin-17 and IR-8 similarly responded to temperature attaining the greatest grain weight at 20 day-temperature (4). However, for the seed germinability the two responded differently. As may be anticipated from their distributions, the germinability and seedling growth of Norin-17 seeds were best at 20 day-temperature, while 30° was the best for IR-8 germinability. These may suggest that the volume of endosperm has a considerable effect on germinability and seedling growth (1), but embryo size, its enzyme activity and other physiological activity of seeds may also be related to the germinability and seedling vigor (2, 6), as shown in the IR-8 seeds which matured at 20° day-temperature, the embryo of which might have been damaged by such a low temperature.

References

1) Bremner, P.M., Eckersall, R.M. and Scott, R.K., *J. Agr. Sci.*, **61**, 139 (1963)
2) Kittock, D.L. and Law, A.G., *Agron, J.*, **60**, 286 (1968)
3) Matsuwo, T., Recent Advancement in Breeding (in Japanese), No. 2, 71 (1961)
4) Sato, K., and Takahashi, M., *Tohoku J. Agr. Res.*, **22**, 57 (1971)
5) Sato, K., *Tohoku J. Agr. Res.*, **22**, 69 (1971)